

SIX FLAGS NEW ENGLAND	
SUBJECT: EXCAVATION, TRENCHING, AND SHORING	SAFETY REFERENCE MANUAL
SECTION: 14	
EFFECTIVE: January 2016	SUPERSEDES: ALL PREVIOUS
CFR #: 29 CFR <b>1926.650</b> – <i>Subpart P</i>	

## **14.1 General**

This procedure is established to control the possibility of creating unsafe conditions on Six Flag properties concerning trenching or excavations having a depth over four (4) feet or more that will be occupied by any workers. Any such procedures shall be reported to the Safety Department prior to digging.

## **14.2 SCOPE**

The intent of this program is to serve as a guide for all employees and contractors who perform excavation work, such as: shoring, trenching, sloping, concrete breaking, stake driving, etc., which is defined by OSHA as "the removal of soil deeper than one foot below the surface," to prevent personal injury and personnel exposure to hazardous compounds that could be present in the soil.

## **14.3 Procedures**

- A. If trenching or excavation shall be done where the depth is from four (4) feet or greater and will be occupied by any workers it must be reported to Risk Management prior to commencing.
- B. Workers who must enter the trench or excavation shall wear hard hats at all times.
- C. When workers are in the trench (or excavation) there must be one person outside of this area and who has radio communication should a problem occur and an escape ladder(s) must be in place.

## **14.4 Definitions Applicable to this Subpart**

- A. ACCEPTED ENGINEERING REQUIREMENTS (OR PRACTICES) - Those requirements *or* practices which are compatible with standards required by a registered architect, a registered professional engineer, or other duly licensed or recognized authority.
- B. ANGLE OF RESPONSE - The greatest angle above the horizontal plane at which a material will lie without sliding.
- C. BANK - A mass of soil rising above a digging level.
- D. BELLED EXCAVATION - A part of a shaft or footing excavation; usually near the bottom and bell-shaped (i.e. an enlargement of the cross section above).

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- E. BRACES (TRENCH) - The horizontal members of the shoring system whose ends bear against the uprights or stringers.
- F. EXCAVATION - Any manmade cavity or depression in the earth's surface, including its sides, walls, or faces, formed by earth removal and producing unsupported earth conditions by reasons of the excavation. If installed forms or similar structures reduce the depth-to-width relationship, an excavation may become a trench.
- G. FACES - See paragraph K of this section.
- H. HARD COMPACT SOIL - All earth materials not classified as running or unstable.
- I. KICKOUTS - Accidental release or failure of a shore or brace.
- J. SHEET PILE - A pile, or sheeting, that may form one of a continuous interlocking line, or a row of timber, concrete, or steel piles, driven in close contact to provide a tight wall or resist the lateral pressure of water, adjacent earth, or other materials.
- K. SIDES or WALLS or FACES - The vertical or inclined earth surfaces formed as a result of excavation work.
- L. SLOPE - The angle with the horizontal at which a particular earth material will stand indefinitely without movement.
- M. STRINGERS (WHALES) - The horizontal members of a shoring system whose sides bear against the uprights or earth.
- N. TRENCH - A narrow excavation made below the surface of the ground. In general, the depth is greater than the width, but the width of a trench is not greater than 15 feet.
- O. TRENCHJACK - Screw or hydraulic type jacks used as cross bracing in a trench shoring system.
- P. TRENCH SHIELD - A shoring system composed of steel plates and bracing, welded or bolted together, which support the walls of a trench from the ground level to the trench bottom and which can be moved along as work progresses.

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- Q. **UNSTABLE SOIL** - Earth material, other than running, that because of its nature or the influence of related conditions cannot be depended upon to remain in place without extra support, such as would be furnished by a system of shoring.
- R. **UPRIGHTS** - The vertical members of a shoring system.
- S. **WALES** - See paragraph M of this section.
- T. **WALLS** - See paragraph K of this section.

#### **14.5 PROCEDURES**

These are the minimum requirements; Refer to OSHA Standard CFR 1926.650-651 for detailed regulations, as follows:

- A. Before excavation work of any type has begun, the site shall be carefully inspected for conditions that may present hazards and an Excavation/Dig Permit is required.
- B. Prior to starting work, the location of underground electrical lines, pipelines, and or other obstructions or potential hazards that may be in the immediate area must be determined. The means of safely uncovering any and all potential hazards shall be agreed upon by a Maintenance Manager, a Maintenance Lead man/Foreman, and if necessary a Contractor Supervisor.
- C. The Supervisor or Lead man/Foreman shall be responsible for acquiring an Excavation Permit, (see Excavation/Dig Permit Admin. in Section 35.9).
- D. The lead man/foreman will train crew members on the scope of the work to be conducted and the potential hazards that could be associated with the work.
- E. All excavation materials and equipment shall be placed a minimum of two (2) feet back from the edge of the excavation work in order to prevent an overload on the banks of the excavation and collapsing onto the workers below.

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- F. In trenches over four (4) feet in depth, ladders shall be provided for each 25 linear feet of trench and the ladders shall extend a minimum of three (3) feet above the trench.
- G. For all soil types except solid rock, the side walls of every excavation over five (5) feet deep must be made safe from collapsing in one (1) of the following ways:
  - 1. SHORING - Brace the walls of the excavation with timber or mechanical means on a vertical plane to prevent a cave-in.
  - 2. SLOPING - Incline the angle away from the excavation at a 45 degree angle. **NOTE:** This will depend on soil strength and environmental conditions.
  - 3. BENCHING - A "series of steps" beginning four (4) feet from the bottom of the excavation and adding a 1'6" horizontal "step" for each one (1) foot vertical henceforth.
- H. All materials used for shoring, bracing, and sheet pilings shall be of substantial strength to adequately withstand any strain to which they are likely to be subjected.
- I. Shoring and walls in excavations shall be protected against damage from swinging loads.
- J. When digging equipment is operating, workers shall stay clear of the bucket. The load shall not be allowed to swing over workers.
- K. Open excavations shall be barricaded or marked with barrier tape as appropriate to prevent trip and fall hazards.
- L. Open excavations in areas without sufficient lighting shall be marked by flashing lights during hours of darkness.
- M. If any welding is to be performed inside of or near the excavation site, a Hot Work Permit will be required.
- N. All employees shall be protected with personal protective equipment for the protection of the head, eyes, respiratory organs, hands, feet, and other parts of the body as set forth in subpart E of this part.

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- O. Employees exposed to vehicular traffic shall be provided with and shall be instructed to wear warning vests marked with or made of reflectorized or high visibility material.

#### **14.6 SOLID ROCK EXCAVATIONS**

##### **A. Use of Jackhammers**

When it is necessary to use a jackhammer to break concrete, the employee using the jackhammer shall be required to wear safety glasses and a face shield, safety toe shoes or boots with metatarsal foot guards, and hearing protection. Other personnel working within twenty (20) feet of the area will be required to wear the same type of protection with exception of metatarsal guards.

##### **B. Hot Work Permits**

Concrete breaking will never be performed in an environment where sparks might cause a fire or explosion. All flammable and combustible material shall be removed from within twenty (20) feet of the work site. If in doubt of the integrity of the work area, a Hot Work Permit shall be needed before work has begun.

##### **C. Unstable Rock**

Unstable rock means: rock that has been excavated and has been placed on the ground above the site. This rock shall be at least two (2) feet from the edge of the excavation and shall be secured against caving-in or movement by "rock bolts", bracing, or by a secured tarp.

#### **14.7 PROTECTION FROM HAZARDS ASSOCIATED WITH WATER ACCUMULATION**

- A. Employees shall not work in excavations in which there is accumulated water or in excavations where water is accumulating, unless adequate precautions have been taken to protect the excavation workers. The precautions necessary to protect employees adequately may vary with each situation, but could include special support or shield systems to protect from cave-ins, water removal to control the level of accumulating water, or use of a safety harness and or lifeline.
- B. If water is controlled or prevented from accumulating by the use of water removal equipment, the equipment and operations shall be monitored by a competent person to ensure the safety of the workers in the trench.

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- C. If excavation work interrupts the natural drainage of surface water, such as streams; diversion ditches, dikes, or other suitable means shall be used to prevent surface water from entering the excavation and to provide adequate drainage to an area adjacent to the excavation site. Excavation subject to heavy rains will require pre-planning for drainage possibilities and will need to be inspected by a competent person (manager or foreman).
- D. Prior to opening an excavation, effort shall be made to determine whether underground installations (i.e. sewer, telephone, water, fuel, electric lines, etc.) will be encountered, and if so, where such underground installations are located. When the excavation approaches the estimated location of such an installation, the exact location shall be determined and when it is uncovered, proper supports shall be provided for the existing installation. Utility companies shall be contacted and advised of proposed work prior to start of actual excavation.
- E. Trees, boulders, and other surface encumbrances, located so as to create a hazard to employees involved in excavation work or in the vicinity thereof at any time during operations shall be removed or made safe before excavating is begun.
- F. The walls and faces of all excavations in which employees are exposed to danger from moving ground shall be guarded by a shoring system, sloping of the ground, or some other equivalent means.
- G. The determination of the angle of repose and design of the supporting system shall be based on careful evaluation of pertinent factors such as: depth or cut; possible variation in water content of the material while the excavation is open; anticipated changes in materials from exposure to air, sun, water, or freezing; loading imposed structures, equipment, overlying material, or stored material, and vibration from equipment, blasting, traffic, or other sources.
- H. Supporting systems (i.e. piling, cribbing, shoring, etc.) shall be designed by a qualified person and meet accepted engineering requirements. When tie rods are used to restrain the top of sheeting or other retaining systems, the rods shall be securely anchored well back of the angle of repose. When light sheeting or sheet piling is used, full loading due to ground water table shall be assumed, unless prevented by weep holes drains or other means. Additional stringers, ties, and bracing shall be provided to allow for any necessary temporary removal of individual supports.
- I. All slopes shall be excavated to at least the angle of repose except for areas where solid rock allows for line drilling or pre-splitting.

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- J. The angle of repose shall be flattened when an excavation has water conditions, silty materials, loose boulders, and areas where erosion, deep frost action, and slide planes appear.
- K. In excavations which employees may be required to enter, excavated or other material shall be effectively stored and retained at least 2 feet or more from the edge of the excavation. As an alternative to the clearance described above, the employer may use effective barriers or other effective retaining devices in lieu thereof in order to prevent excavated or other materials from falling into the excavation.
- L. Sides, slopes, and faces of all excavations shall meet accepted engineering requirements by scaling, wire meshing, or other equally effective means. Special attention shall be given to slopes which may be adversely affected by weather or moisture content.
- M. Support systems shall be planned and designed by a qualified person when excavation is in excess of 20 feet in depth, adjacent to structures or improvements, or subject to vibration or ground water.
- N. Materials used for sheeting, sheet piling, cribbing, bracing, shoring, and underpinning shall be in good serviceable condition, and timbers shall be sound, free from large or loose knots, and of proper dimensions.
- O. Special precautions shall be taken in sloping or shoring the sides of excavations adjacent to a previously back-filled excavation of a fill, particularly when the separation is less than the depth of the excavation. Particular attention also shall be paid to joints and seams of material comprising a face and the slope of such seams and joints.
- P. Except in hard rock, excavations below the level of the base or footing of any foundation or retaining wall shall not be permitted, unless the wall is underpinned and all other precautions taken to insure the stability of the adjacent walls for the protection of employees involved in excavation work or in the vicinity thereof.
- Q. If the stability of adjoining buildings or walls is endangered by excavation, shoring, bracing, or underpinning shall be provided as necessary to insure employee safety. Such shoring, bracing, or underpinning shall be inspected daily or more often, as conditions warrant, by a competent person and the protection effectively maintained.

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- R. Diversion ditches, dikes, or other suitable means shall be used to prevent surface water from entering an excavation and to provide adequate drainage of the area adjacent to the excavation. Water shall not be allowed to accumulate in an excavation.
- S. If it is necessary to place or operate power shovels, derricks, trucks, materials, or other heavy objects on a level above and near an excavation, the side of the excavation shall be sheet-piled, braced as necessary, to resist the extra pressure due such superimposed loads.
- T. Blasting and the use of explosives shall be performed in accordance with subpart U of this part.
- U. When mobile equipment is utilized or allowed adjacent to excavations, substantial stop logs or barricades shall be installed. If possible, the grade should be away from the excavation.
- V. Adequate barrier protection shall be provided at all remotely located excavations. All wells, pits, shafts, etc., shall be barricaded or covered. Upon completion of exploration and similar operations, temporary wells, pits, shafts, etc. shall be back-filled.
- W. If possible, dust conditions shall be kept to a minimum by the use of water, salt, calcium chloride, oil, or other means.
- X. In locations where oxygen deficiency or gaseous conditions are possible air in the excavation shall be tested. Controls as set forth in subparts D and E of this part, shall be established to assure acceptable atmospheric conditions. When flammable gases are present, adequate ventilation shall be provided or sources of ignition shall be eliminated. Attended emergency rescue equipment, such as breathing apparatus, a safety harness and line, basket stretcher, etc., shall be readily available where adverse atmospheric conditions may exist or develop in an excavation.
- Y. Where employees or equipment are required or permitted to cross over excavations, walkways or bridges with standard guardrails shall be provided.
- Z. Where ramps are used for employees or equipment, they shall be designed and constructed by qualified persons in accordance with accepted engineering requirements.

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AA. All ladders used on excavation operations shall be in accordance with the requirements of subpart L of this part.

#### **14.8 Specific Trenching Requirements**

- A. Banks more than 5 feet high shall be shored, laid back to a stable slope, or some other equivalent means of protection shall be provided where employees may be exposed to moving ground and/or cave-ins. Refer to Table P-I as a guide in sloping of banks. Trenches less than 5 feet in depth shall also be effectively protected when examination of the ground indicates hazardous ground movement may be expected.
- B. Sides of trenches in unstable or soft material 4 feet or more in depth, shall be shored, sheeted, braced, sloped, or otherwise supported by means of sufficient strength to protect the employees working within them. See Tables P-1 P-2 following paragraph of this section.
- C. Sides of trenches in hard or compact soil, including embankments, shall be restored or otherwise supported when the trench is more than 4 feet in depth and 8 feet in length. In lieu of shoring, the sides of the trench above the 4 foot level may be sloped to preclude collapse, but shall not be steeper than a 1 foot rise to each horizontal. When the outside diameter of a pipe is greater than 6 feet, a bench of 4' minimum shall be provided at the sloped portion.
- D. Materials used for sheeting and sheet piling, bracing, shoring, and underpinning, shall be in good serviceable condition, and timbers used shall be sound and free from large or loose knots, and shall be designed and installed so as to be effective to the bottom of the excavation.
- E. Additional precautions by way of shoring and bracing shall be taken to prevent slides or cave-ins when excavations or trenches are made on locations adjacent to back filled excavations, or where excavations are subjected to vibrations from railroad or highway traffic, the operation of machinery, or any other source.
- F. Employees entering bell-bottom pier holes shall be protected by the installation of a removable-type casing of sufficient strength to resist shifting of the surrounding earth. Such temporary protection shall be provided for the full depth of that part of each pier hole, which is above the bell. A lifeline, suitable for instant rescue and securely fastened to a shoulder harness shall be worn by each employee entering the shafts. This lifeline shall be individually manned and separate from any line used to remove materials excavated from the bell footing.

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G. Minimum requirements for trench timbering shall be in accordance with Table P-I.

Braces and diagonal shores in wood shoring system shall not be subjected to compressive stress in excess of value given by the following formula:

$$S=1300-20L/D$$

**Maximum Ration L/D-50**

Where:

L = length, unsupported, in inches

D = least side of the timber in inches

S = allowable stress in pounds per square inch of cross-section

H. When employees are required to be in trenches 4 feet deep or more, an adequate means of exit, such as a ladder or steps, shall be provided and located so as to require no more than 25 feet of lateral travel.

I. Bracing or shoring of trenches shall be carried along with the excavation.

J. Cross braces or trench jacks shall be placed in true horizontal position, be spaced vertically, and be secure to prevent sliding, failing, or kick outs.

K. Portable trench boxes or sliding trench shields may be used for the protection of personnel in lieu of shoring system or sloping. Where such trench holes or shields are used, they shall be designed, constructed, and maintained in a manner which will provide protection equal to or greater than the sheeting or shoring required for the trench.

L. Back filling and removal of trench supports shall progress together from the bottom of the trench. Jacks or braces shall be released slowly and, under unstable conditions, ropes shall be used to pull out the jacks or braces from above after employees have cleared the trench.

#### **14.9 EXCAVATION / DIG PERMIT PROGRAM / ADMINISTRATION**

The Security Department, Maintenance Managers, Supervisor and Lead man/Foreman will administer the Excavation/Dig Permit Program. The Permit system ensures that Maintenance, Security, and Safety personnel are fully aware of the excavation work to be performed and any associated risk of potential hazards to employees that may exist. The Excavation/Dig Permit, in accordance with the Excavation Procedures, also ensures that the proper precautions are taken as necessary throughout the excavation process.

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The Security Department will issue Maintenance Supervisors and Lead man/Foreman Excavation/Dig Permits.

Maintenance Supervisors and Foremen must cover any applicable regulations and precautions outlined in the Excavation Procedures with individuals performing the excavation work. Adequate precautionary measures to prevent employee exposure to potential hazards will be agreed upon by a Maintenance Manager, Supervisor, Lead man/Foreman, and if necessary, a Contractor Supervisor. In addition, periodic checks shall be made by Supervisory personnel during excavation operations to ensure all necessary precautions are adequately being taken.

When issuing the Excavation/Dig Permit, the Security Department will document the excavation work operation on the radio log and will relay the information regarding the excavation activity and location to next shift Security Personnel.

The individual who will be completing a job requiring excavation will assemble his or her materials, supplies and work crew. He or she will then request an Excavation/Dig Permit from the Security Department. The individual performing the work will fill out the permit and have it signed by a Maintenance Manager. The completed permit will then be hung conspicuously in the area where the excavation work is to be performed. After completion of the excavation, the Maintenance Crew Supervisor or Foreman shall be responsible for reporting the completed excavation work operations to the on-duty Security Dispatcher. The Security Dispatcher will then record the excavation work completion time on the radio log.

It is the responsibility of the individual completing excavation operations to ensure that all applicable (procedural) safety conditions are complied with. The responsible party will also communicate with other persons in the work area to ensure safe knowledge of activities.

An Excavation/Dig Permit will be considered active until the completion of the excavation operations, even though the job may last several days. The Excavation/Dig Permit will be left at the work site until the completion of the excavation work.

When the job is completed, the Permit is to be turned into the on-duty Security Dispatcher by the responsible Maintenance Supervisor or Lead man/Foreman. Security will turn in all completed permits to the Safety Department. Safety and Security Officers will also monitor safety conditions periodically throughout the excavation operations.

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Completed records of permit activity shall be maintained for at least one year for review by facility management and Risk Management consultants. The Safety Department will review Excavation Procedures and Records.

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## BEFORE YOU EXCAVATE

1. Contact the utility companies or property owners and ask the companies or owners to find the exact location of the underground installations in the area. If the utility companies or owners do not respond within 24 hours or the period established by law or ordinance, or if they cannot establish the location of the utility lines, the excavation may proceed with caution. In this situation, the employer must provide employees with detection equipment or other safe and acceptable means to locate utility installations.
2. Remove or adequately support objects in the excavation area that could create a hazard to employees. These may include trees, rocks, sidewalks, and other objects.
3. Classify the type of soil and rock deposits at the site as either stable rock, Type A, Type B or Type C soil. The soil classification must be made based on the results of at least one visual and at least one manual analysis conducted by a competent person. (Note: Soil classification is not necessary if the excavation will be sloped to an angle of one and one-half horizontal to one vertical.)

## SOIL CLASSIFICATION

Each soil and rock deposit at an excavation site must be classified by a competent person as stable rock, Type A, Type B, or Type C soil.

Stable rock refers to natural solid mineral matter which can be excavated with vertical sides and remain intact while exposed.

Type A soil is cohesive with an unconfined compressive strength of 1.5 tons per square foot (tsf). Type A soils include clay, silty clay, sandy clay, clay loam, earache, hardpan, and sometimes silty clay loam and sandy clay loam. No soil should be classified as Type A if it is fissured; subject to vibration from traffic, pile driving, or similar effects; previously disturbed; or part of a sloped, layered system where the slope is four horizontal to one vertical or greater.

Type B soil is cohesive soil with an unconfined compressive strength greater than .5 tsf but less than 1.5 tsf. Type B soils include granular cohesionless soils like angular gravel, silt, silt loam, sandy loam, and sometimes silty clay loam and sandy clay loam; previously disturbed soils that are not Type C; fissured soils and soils subject to

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vibration that would otherwise be classified as Type A; dry rock that is not stable; and material that is part of a sloped, layered system where the layers dip on a slope less steep than four horizontal to one vertical.

Type C soil is cohesive soil with an unconfined compressive strength of .5 tsf or less. Type C soils include granular soils such as gravel, sand, and loamy sand; submerged soil; soil from which water is freely seeping; submerged rock that is not stable; or material in a sloped, layered system where the layers dip into the excavation at a slope of four horizontal to one vertical or steeper.

Soil classification is to be based on at least one visual analysis and one manual analysis of the soil. Details of the acceptable visual and manual analyses may be found in Appendix A of the excavation standard.

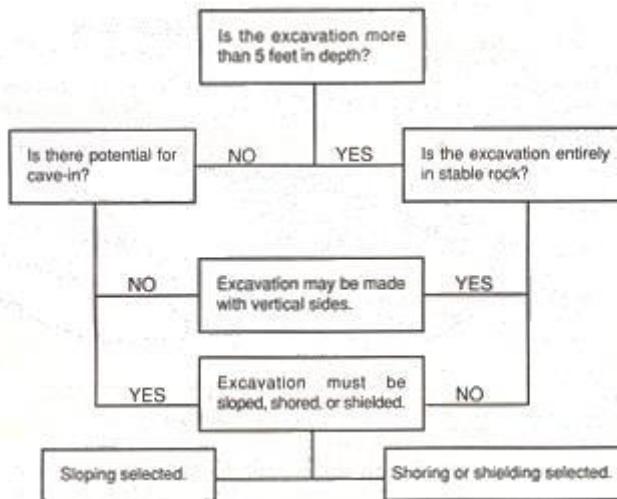
## PROTECTIVE SUPPORT SYSTEMS

OSHA requires that each employee in an excavation be protected from cave-ins during an excavation by an adequate protective system designed in accordance with OSHA standards. Protective system options include proper sloping or benching of the sides of the excavation; supporting the sides of the excavation with timber shoring or aluminum hydraulic shoring; or placing a shield between the side of the excavation and the work area. The employer is free to choose the most practical design approach for any particular circumstance. Once an approach has been selected, however, the required performance criteria must be met by that system.

No protective system is necessary if the excavation is made entirely in stable rock, or the excavation is less than 5 feet (1.52 m) in depth (provided there is no indication of a potential cave-in).

The following figure is a graphic summary of the preliminary decisions which need to be made in order to determine whether a protective system is needed for an excavation 20 feet or less in depth. Protective systems for use in excavations more than 20 feet in depth must be designed by a registered professional engineer.

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## SLOPING AND BENCHING

If sloping or benching is used to protect against cave-ins, there are four basic options that can be chosen for designing sloping or benching systems. First, if soil classification is not made, then the sides of the excavation can be sloped to an angle not steeper than one and one-half horizontal to one vertical (34°). A slope of this gradation or less is considered safe for any type of soil (see Figure 1).

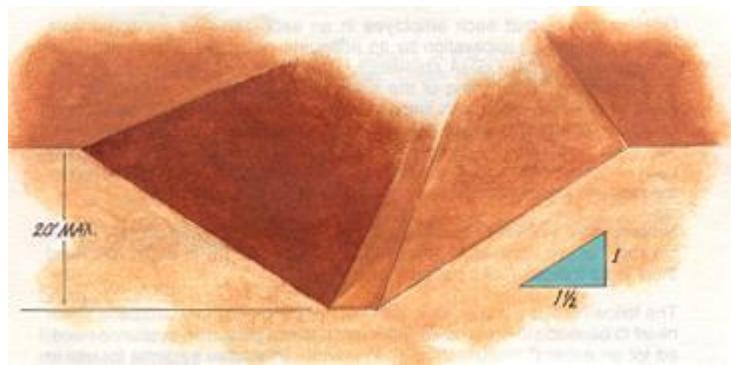


Figure 1: Simple slope of 1-1/2 H to 1 V; Suitable for all soil types in excavations less than 20 feet in depth.

The second option for designing a sloping or benching system is to use Appendices A and B of the excavation standard to determine the maximum allowable slope and allowable configurations for sloping and benching systems. These requirements are summarized in Table 1. The soil type must be determined in order to use this option.

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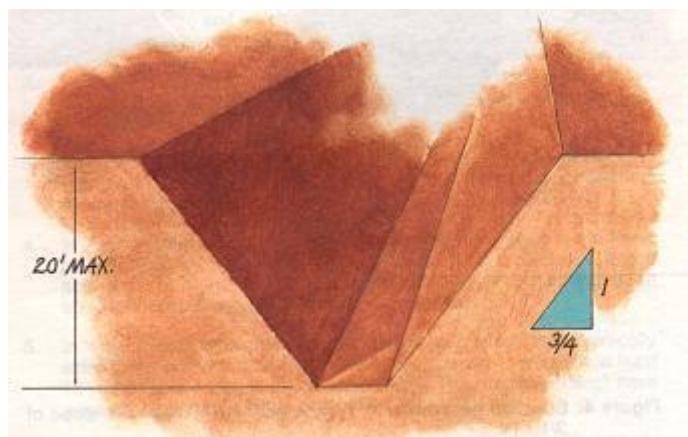
**Table 1**  
**Maximum Allowable Slopes**

SOIL OR ROCK TYPE	MAXIMUM ALLOWABLE SLOPES (H:V) <sup>1</sup> FOR EXCAVATIONS LESS THAN 20 FEET DEEP <sup>3</sup>
STABLE ROCK	VERTICAL (90°)
TYPE A <sup>2</sup>	3/4:1 (53°)
TYPE B	1:1 (45°)
TYPE C	1-1/2:1 (34°)

**NOTES:**

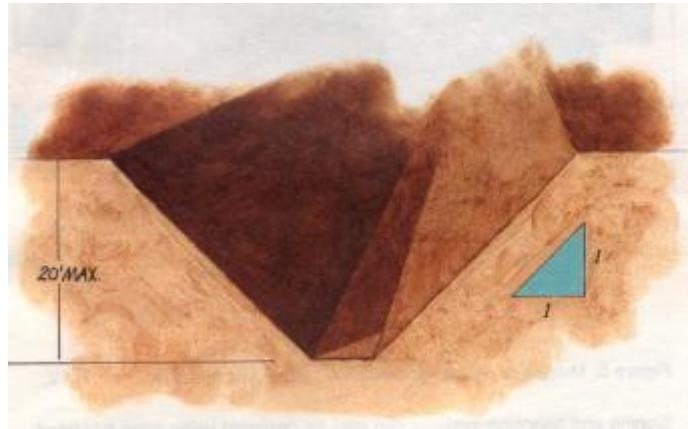
1. Numbers shown in parentheses next to maximum allowable slopes are angles expressed in degrees from the horizontal. Angles have been rounded off.
2. A short-term maximum allowable slope of 1/2H: 1V (63) is allowed in excavations in Type A soil that are 12 feet (3.67 m) or less in depth. Short-term maximum allowable slopes for excavations greater than 12 feet (3.67 m) in depth shall be 3/4H: 1 V (53).
3. Sloping or benching for excavations greater than 20 feet deep shall be designed by a registered professional engineer.

*Figures 2 and 3 provide examples of simple slope excavations in Type A and Type B soils. Figures 4 and 5 illustrate the use of single and multiple benching in Type A and B soils.*

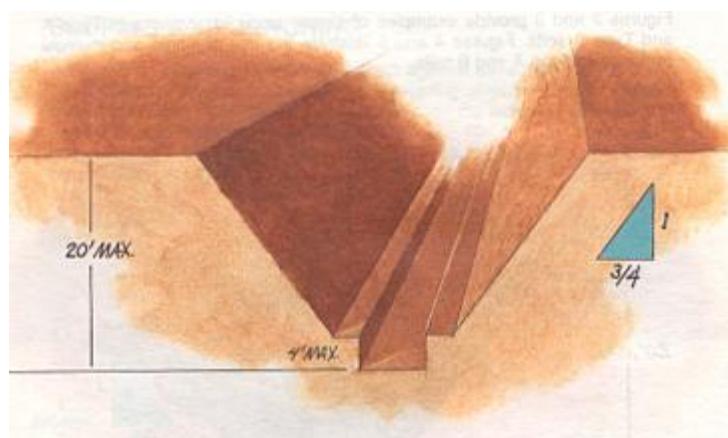


**Figure 2:** Simple slope excavation in Type A soil with a 3/4H: 1 V slope.

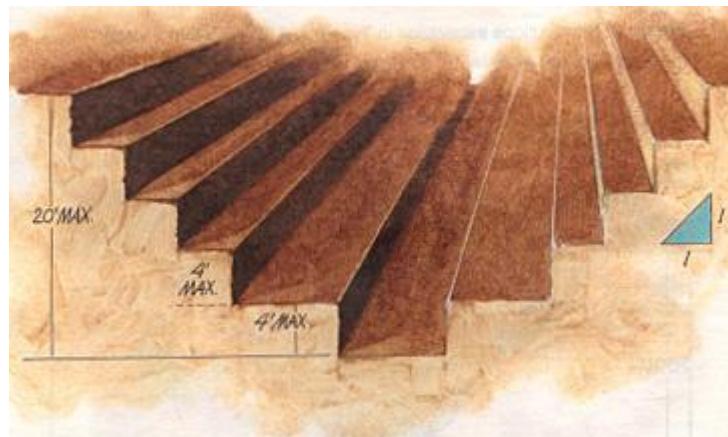
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**Figure 3:** Simple slope excavation in Type B soil with a 1 H:1 V slope.



**Figure 4:** Benched excavation in Type A soil with a maximum slope of 3/4H: 1 V.



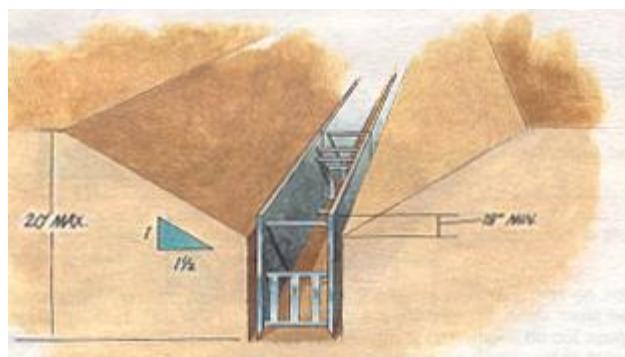
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**Figure 5:** Multiple benched excavation in Type B soil with a slope of 1H:1V.

Sloping and benching systems can also be designed using other tabulated data approved by a registered professional engineer or by having an engineer design and approve the system to be used.

There are a number of exceptions or special cases to these general sloping and benching guidelines. They are outlined below.

1. In Type A soil, simple slope excavations which are open 24 hours or less (short term) and which are 12 feet high or less in depth may have a maximum allowable slope of 1/2 horizontal to 1 vertical.
2. In Type A soil, all excavations 8 feet or less in depth which have unsupported vertically sided lower portions must have a maximum vertical side of 3.5 feet.
3. In Type A soil, excavations over 8 feet but less than 12 feet in depth with unsupported vertically sided lower portions must have a maximum allowable slope of 1H:1V and a maximum vertical side of 3.5 feet.
4. In Type A soil, excavations 20 feet or less with vertically sided lower portions that are supported or shielded shall have a maximum allowable slope of 3/4H:1V. The support or shield system must extend at least 18 inches above the top of the vertical side.
5. In Type B soil, all excavations 20 feet or less which have vertically sided lower portions shall be shielded or supported to a height at least 18 inches above the top of the vertical side. The excavation shall have a maximum allowable slope of 1H:1V.
6. In Type C soil, all excavations 20 feet or less which have vertically sided lower portions shall be shielded or supported to a height at least 18 inches above the top of the vertical side. The excavation shall have a maximum allowable slope of 1-1 /2H:1 V. See Figure 6 for an example of this type of excavation.



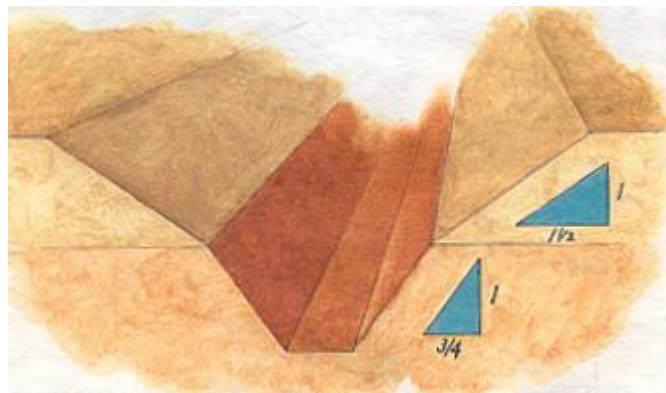
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**Figure 6:** Excavation in Type C soil with shielded vertically sided lower portions. The excavation is sloped at 1-1/2H:1 V.

## LAYERED SOILS

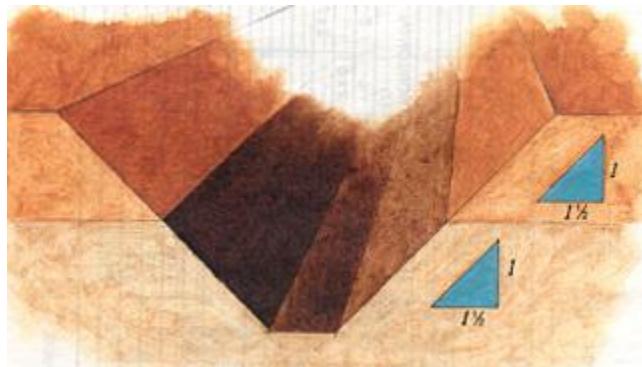
When the excavation contains layers of different types of soils, the general sloping requirements do not apply. The excavation must be sloped according to Table 2. Figures 7 and 8 provide examples of excavations made in layered soils.

Table 2			
Sloping Requirements for Layered Soils			
Slope Required For Each Soil Layer			
Layered Soil Type	Type A Layer	Type B Layer	Type C Layer
B over A	3/4:1	1:1	
C over A	3/4:1		1-1/2:1
C over B		1:1	1-1/2:1
A over B	1:1	1:1	
A over C	1-1/2:1		1-1/2:1
B over C		1-1/2:1	1-1/2:1



**Figure 7:** Excavation in layered soil (Type C over Type A). The layer of Type C soil is sloped at 1-1/2:1, while the layer of Type A soil is sloped at 3/4:1.

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**Figure 8:** Excavation in layered soil where Type A soil tops Type C soil. Both the Type A and Type C soils in the excavation must be sloped at 1-1/2: 1.

## TIMBER SHORING

Designs for timber shoring in trenches can be determined using one of four methods: using the requirements set forth by OSHA in Appendices A and C of the excavation standard; using data provided by the manufacturer of the support system; using other tabulated data approved by an engineer; or having a registered professional engineer design the system.

The design specifications for timber shoring provided by OSHA may be found in Tables 3, 4, and 5 on the following pages.

These tables refer to the actual dimensions and not nominal dimensions of the timber. Those wishing to use nominal size shoring are directed to the additional tables found in Appendix C of the standard.

These OSHA design specifications apply only to trenches that do not exceed 20 feet. The soil type in which the excavation is made must be determined in order to use the OSHA data. The specifications do not apply in every situation experienced in the field; the data were developed to apply to most common trenching situations.

Figure 9 illustrates the use of timber shoring as a protective system.

### **TIMBER TRENCH SHORING - MINIMUM TIMBER REQUIREMENTS\***

$$\text{SOIL TYPE A } P_a = 25 \times H + 72 \text{ psf (2 ft Surcharge)}$$

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\*Mixed oak or equivalent with a bending strength not less than 850 psi.

\*\*Manufactured members of equivalent strength may be substituted for wood.

## **TIMBER TRENCH SHORING - MINIMUM TIMBER REQUIREMENTS\***

SOIL TYPE B  $P_a = 45 \times H + 72$  psf (2 ft Surcharge)

DEPTH OF TRENCH (FEET)	SIZE (ACTUAL) AND SPACING OF MEMBERS**											
	CROSS BRACES											UPRIGHTS
	HORIZ. SPACIN G FEET	WIDTH OF TRENCH (FEET)					VERT. SPACIN G (FEET)	SIZE (IN.)	VERT. SPACIN G (FEET)	MAXIMUM ALLOWABLE HORIZONTAL SPACING (FEET)		
DEPTH OF TRENCH (FEET)		UP TO 4	UP TO 6	UP TO 9	UP TO 12	UP TO 15				CLOS E	2	3
5 TO 10	UP TO 6	4X6	4X6	6X6	6X6	6X6	5	6X8	5			2X 6
	UP TO 8	6X6	6X6	6X6	6X8	6X8	5	8X10	5			2X 6
	UP TO 10	6X6	6X6	6X6	6X8	6X8	5	10X1 0	5			2X 6
	See Note 1											
10 TO 15	UP TO 6	6X6	6X6	6X6	6X8	6X8	5	8X8	5			2X 6
	UP TO 8	6X8	6X8	6X8	6X8	6X8	5	10X1 0	5			2X 6
	UP TO 10	8X8	8X8	8X8	8X8	8X10	5	10X1 2	5			2X 6
	See Note 1											
15 TO 20	UP TO 6	6X8	6X8	6X8	8X8	8X8	5	8X10	5	3X6		
	UP TO 8	8X8	8X8	8X8	8X8	8X10	5	10X1 2	5	3X6		

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\*Mixed oak or equivalent with a bending strength not less than 850 psi.

\*\*Manufactured members of equivalent strength may be substituted for wood.

## **TIMBER TRENCH SHORING - MINIMUM TIMBER REQUIREMENTS\***

SOIL TYPE C  $P_a = 80 \times H + 72$  psf (2 ft Surcharge)

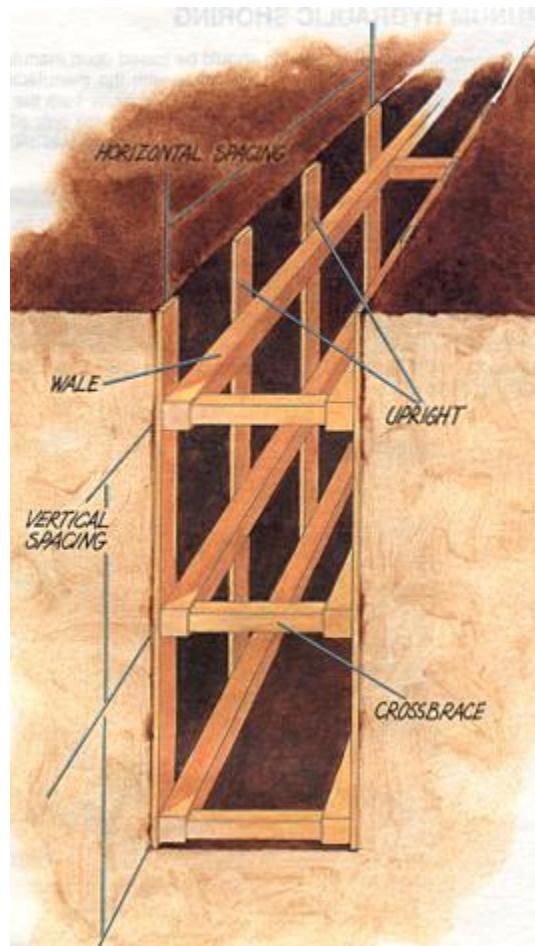
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	See Note 1											
15 TO 20	UP TO 6	8X1 0	8X1 0	8X1 0	8X1 0	10X1 0	5	12X1 2	5	3X6		
	See Note 1											
	See Note 1											
	See Note 1											
OVER 20	SEE NOTE 1											

\*Mixed oak or equivalent with a bending strength not less than 850 psi.

\*\*Manufactured members of equivalent strength may be substituted for wood.

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**Figure 9:** This illustrates timber shoring in a trench approximately 13 feet deep and 5 feet wide in Type B soil. Using OSHA specifications described in Table 4, the 6 x 6 crossbraces have been placed at 6 feet horizontally and 5 feet vertically; the 8 x 8 wales are positioned at five feet vertically; and the 2 x 6 uprights are placed every two feet.

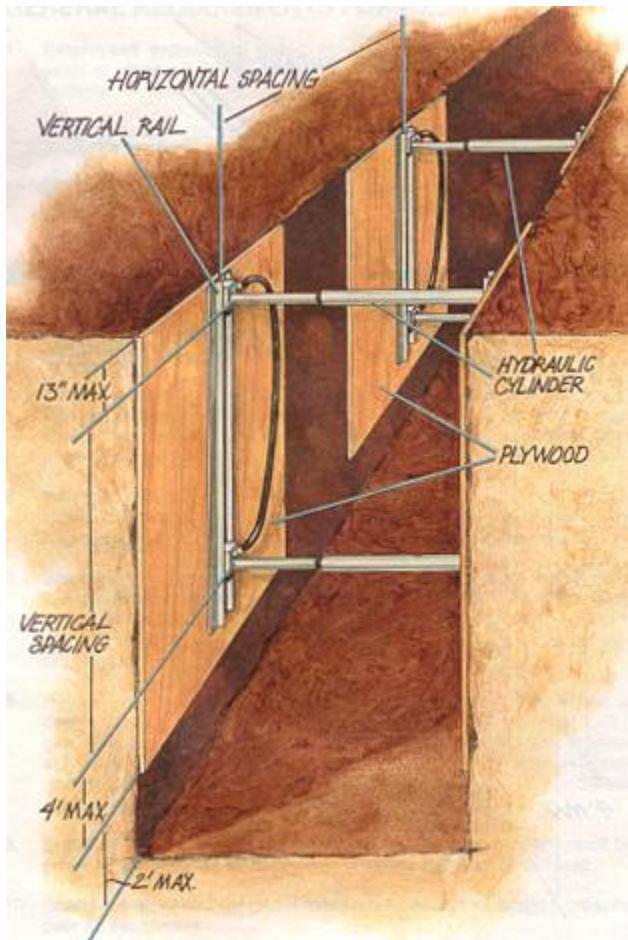
## ALUMUNUM HYDRAULIC SHORING

Designs for aluminum hydraulic shoring should be based upon manufacturer's tabulated data and should be in accordance with the manufacturer's specifications, recommendations, and limitations. Deviations from the manufacturer's specifications, recommendations, or limitations are only allowed upon written approval of the manufacturer. The written approval must be kept at the jobsite during construction of the protective system.

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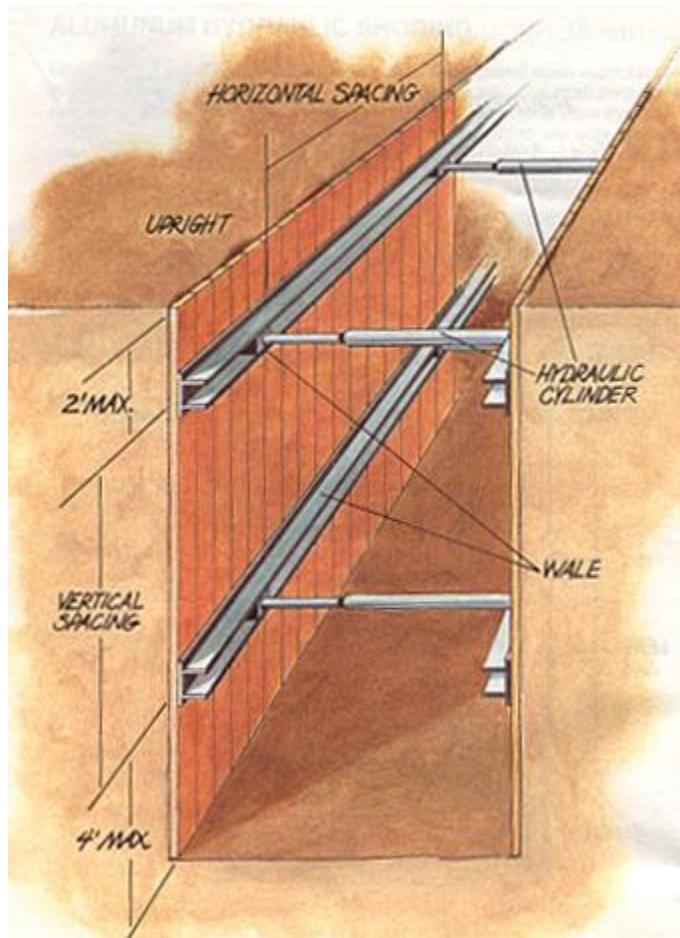
If the manufacturer's tabulated data cannot be utilized, the aluminum hydraulic shoring can be designed using the OSHA specifications found in Appendix D of the excavation standard. Before using the OSHA data, the soil type must be determined. Other options for the design of aluminum hydraulic shoring systems include using other tabulated data approved by an engineer or having a registered professional engineer design the system.

Figures 10 and 11 provide examples of vertical aluminum hydraulic shoring and a horizontal waler system. These illustrations use OSHA specifications for the shoring design.



**Figure 10:** Vertical aluminum hydraulic shoring in a trench dug in soil Type B. The vertical shores and 2 inch diameter cylinders are placed 5.5 feet o.c. horizontally and 4 feet o.c. vertically. Plywood is used behind the shores to prevent local raveling between shores.

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**Figure 11:** A horizontal waler system in a trench dug in Type C soil. Horizontal 2 inch cylinders are spaced at 6.5 feet o.c. horizontally. Wales are spaced 4 feet o.c. vertically and 3 x 12 solid timber sheeting is used.

## GENERAL REQUIREMENTS FOR EXCAVATIONS

1. Employees exposed to public vehicular traffic must wear warning vests or other suitable garments made of reflectorized or high-visibility material.
2. A competent person must inspect the excavation and the adjacent areas on a daily basis for possible cave-ins, failure of protective systems and equipment, hazardous atmospheres, or other hazardous conditions. Inspections are also required after the occurrence of any natural (such as rain) or man-made events (such as blasting) that could increase the potential for hazards.
3. A warning system should be used to alert operators of the edge of an excavation.

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4. Adequate protection must be provided to protect employees from failing rock, soil, or other materials and equipment.
5. Employees should not be permitted under loads that are handled by lifting or digging equipment. Employees should not be allowed to work in the excavation above other employees unless the lower level employees are adequately protected.
6. While the excavation is open, underground installations must be protected, supported, or removed as necessary to safeguard employees. Adjacent structures must be supported to prevent possible collapse.
7. Employees should not be permitted to work in excavations where water has accumulated or is accumulating unless adequate precautions have been taken. Diversion ditches, dikes, or other means must be used to prevent surface water from entering an excavation and to provide drainage to the adjacent area.
8. Before an employee enters an excavation greater than 4 feet in depth, a competent person must test the atmosphere where oxygen deficiency or a hazardous atmosphere exists or could reasonably exist. Emergency rescue equipment must be readily available and must be attended when hazardous atmospheric conditions exist or may develop.
9. Sufficient means for exiting excavations 4 feet deep or more must be provided and must be within 25 feet of lateral travel for employees.
10. Guardrails must be provided if there are walkways or bridges crossing over an excavation.